

Advances, challenges and opportunities in Contactless fingerprint capture

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OVERVIEW

→ Introduction

- Contact / contactless
- Use of dedicated sensor
- Contactless technologies:

→ Two different design choices for contactless technologies

- MorphoWave (formerly called « Finger-on-the-fly »)
 - Principle, usage & benefits, challenges
 - Performance / Certification / interoperability
- Direct view on smartphone
 - Principle, usage / benefits, challenges
 - Performance / Certification / interoperability

→ Conclusion, next steps

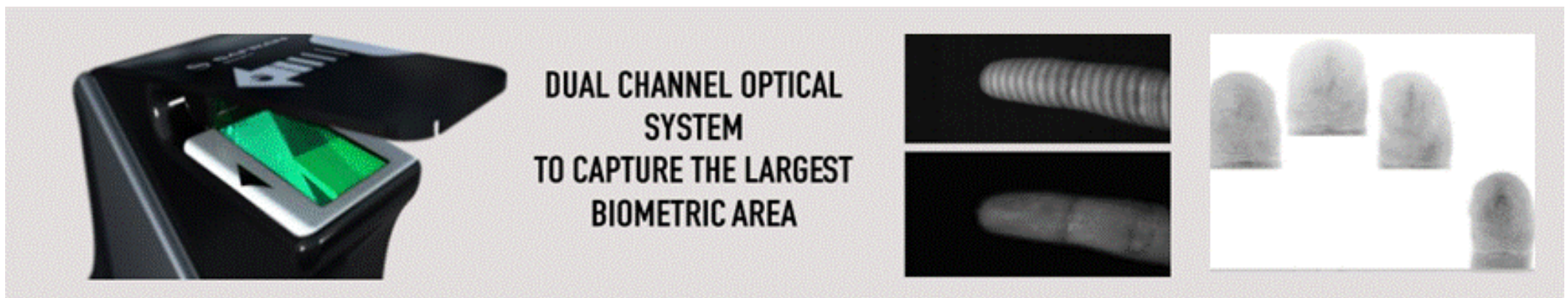
MORPHOWAVE TECHNOLOGY

→ Acquisition of four fingers in a single swipe of the hand

- Fast : Capture of 4 fingers in less than a second
- Accurate: Large capture area and robustness to difficult fingers (wet and dry fingers)
- Interoperable: PIV certified sensor (500dpi)
- Contactless & easy to use

→ MorphoWave design choices

- 3D modeling of finger shape (not ridge shape) using structured light technology
- Contrast enhancement by directional lighting
- Interoperable 2D image generated by unwrapping the texture image using the 3D model



APPLICATIONS, BENEFITS & CHALLENGES

→ Possible applications

- Border control
- Access control
- Rapid enrolment & ID verification
- .../...



→ Many operational advantages

- Speed
- Ergonomics & user experience
- Hygien
- .../...



→ But several legitimate questions:


- What is the accuracy ?
- Is it interoperable with legacy databases and legacy sensors ?
- How does it compares to traditional rolled and slaps ?

And how
can we
validate this ?

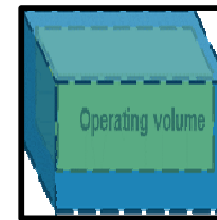
1- FIDELITY - PIV CERTIFICATION (SINGLE FINGER)

Adaptation of PIV certification procedure to MorphoWave Technology

- ⇒ Same reference documents
- ⇒ Same set of targets
- ⇒ Same metrics & tools
- ⇒ Measure of metrics within the volume area

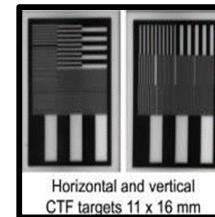
Main Category	Firm ^	Product & Description		FAP	Specification
PIV Single Finger Capture Devices	Safran Morpho	Finger On The Fly / Morphowave Desktop Model Finger On The Fly / Morphowave Desktop contactless, up to 4-finger, livescan capture device at 500ppi (PIV-071006). Note: Device images a 3-dimensional object, but testing was only 2-dimensional - Not for use with CJIS systems			PIV

From <https://www.fbi Biospecs.cjis.gov/Certifications>



Define 3D capture volume

2D Ronchi target for resolution/distortion



2D CTF targets

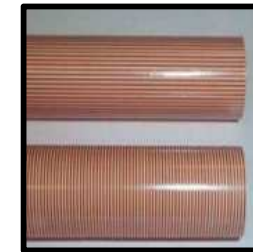
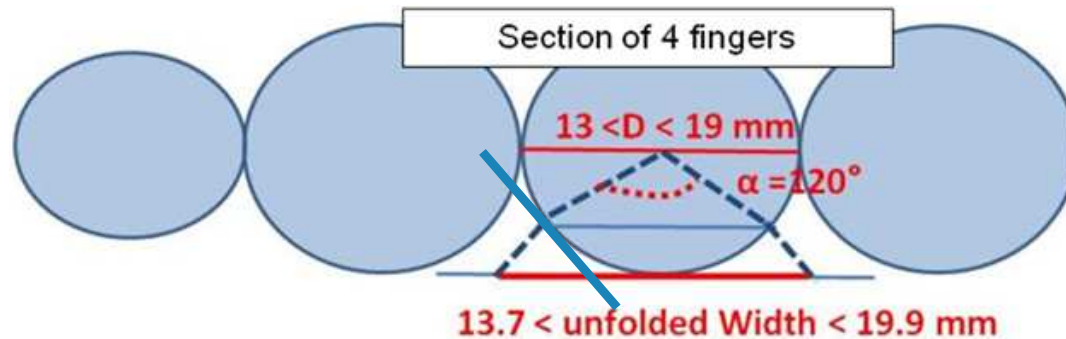
2D Uniform targets for GLU, SNR and uniformity



Gray range on fingers and comparison with inked images

2- FIDELITY – TEST ON 3D TARGETS

→ A finger is a non flat 3D object



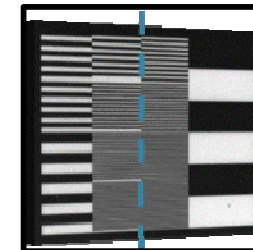
3D « Ronchi » target to check 3D->2D fidelity

2 diameters (14-17 mm) to take finger size into account



1) Ensure optical properties on non horizontal area

- Geometry
- Resolution



Tilted targets to ensure fidelity on side

2) Correct projection distortion to ensure compatibility with legacy databases

- Unwrapping from 3D shape
 - E.g « 3D touchless fingerprints: compatibility with legacy rolled images” by Chen, Parziale2, Diaz-Santana, and Jain
- Impact on distortion > 2% on the side of the finger. Can it be neglected ?

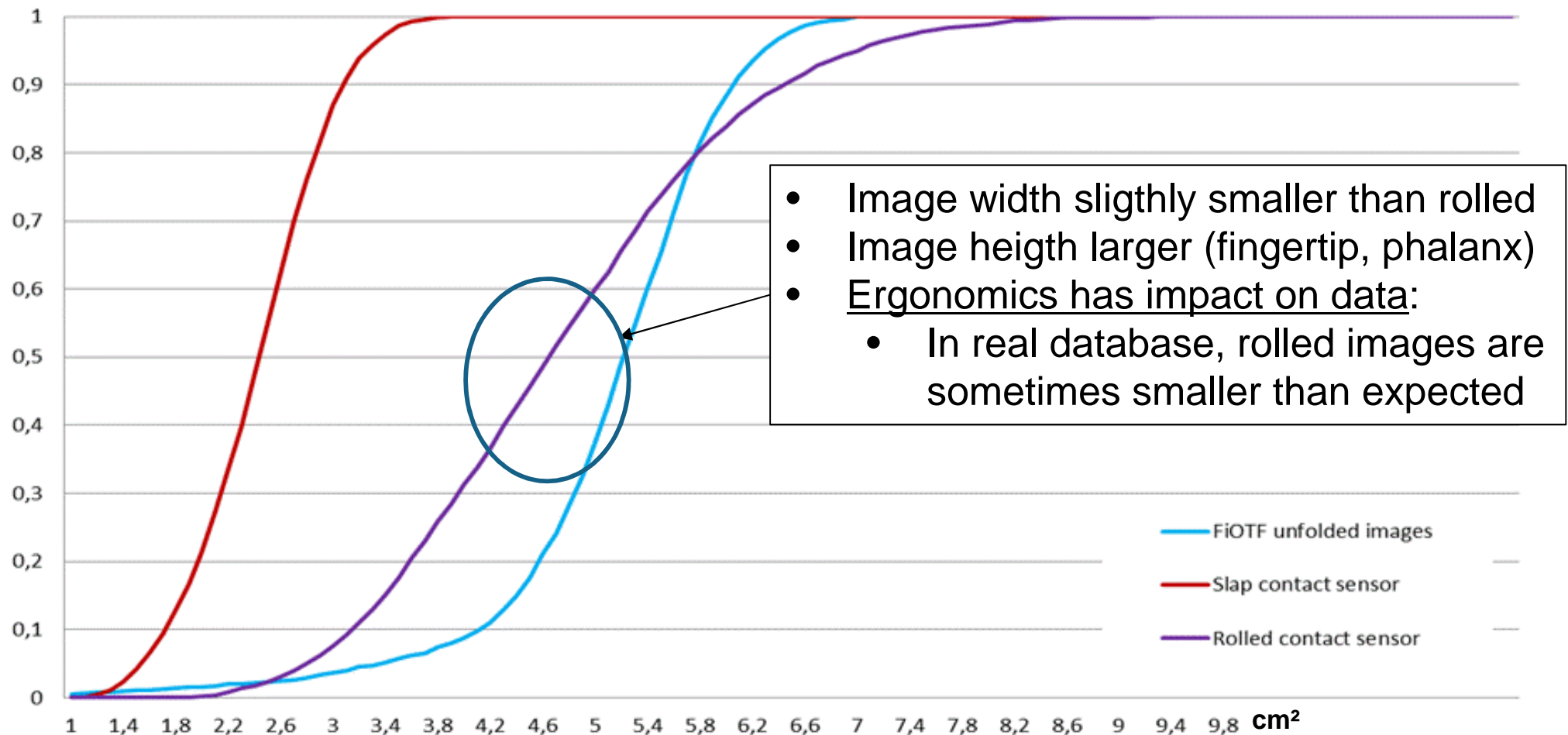
3- ASSESSMENT OF QUANTITY OF INFORMATION

→ The area of the fingerprint captured is between slap and rolled



3- ASSESSMENT OF QUANTITY OF INFORMATION

→ Statistical measures of FiOTF fingerprint areas are closer to rolled than slap



4- INDEPENDENT TESTING

“NON-CONTACT MULTI-SENSOR FINGERPRINT COLLECTION – PHASE II, 11/2014 - 4/2015 »

From <https://www.ncjrs.gov/pdffiles1/nij/grants/249552.pdf>

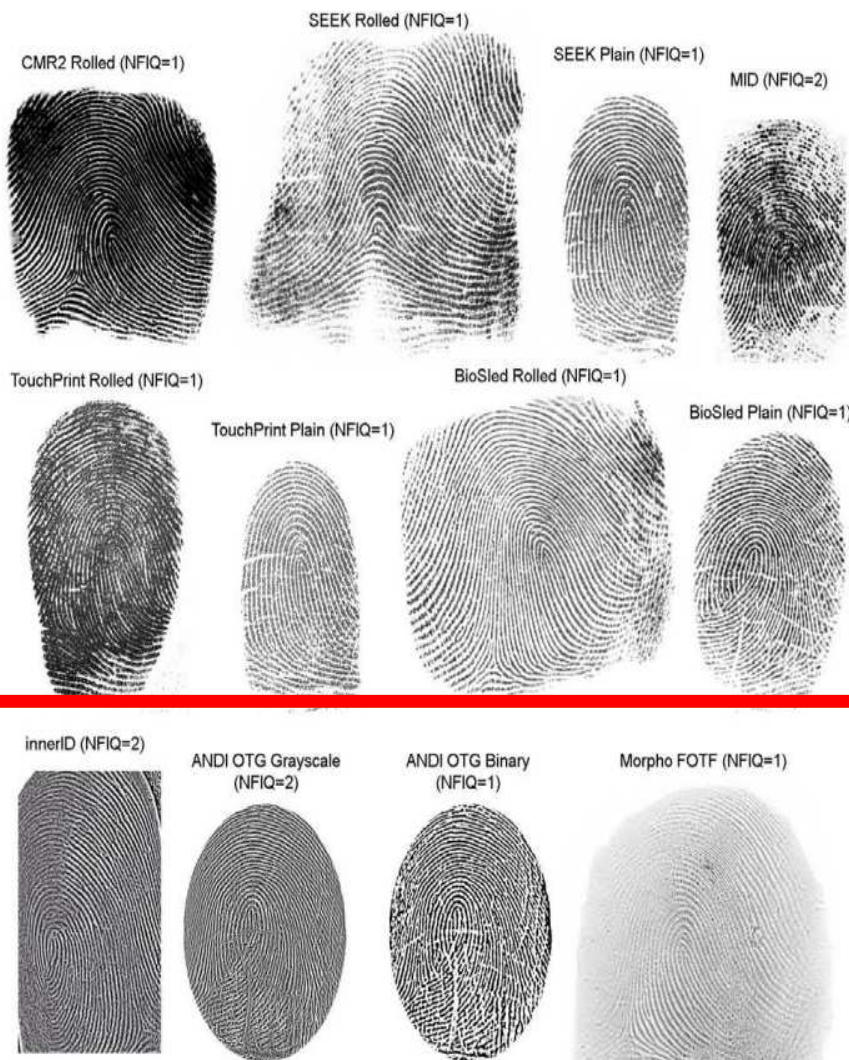
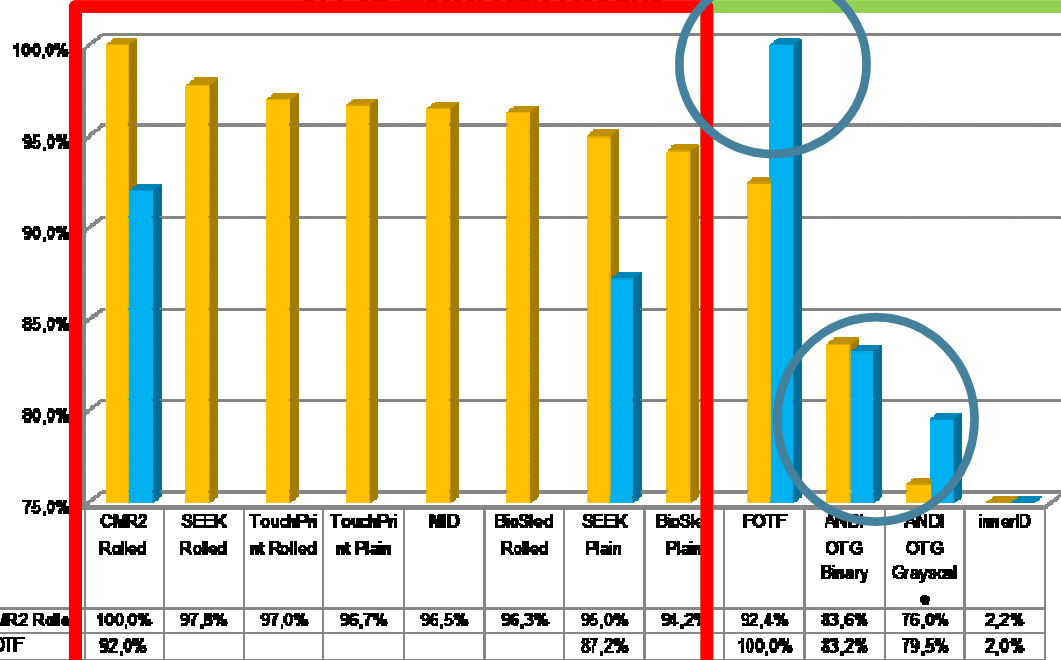
Contact



Contactless



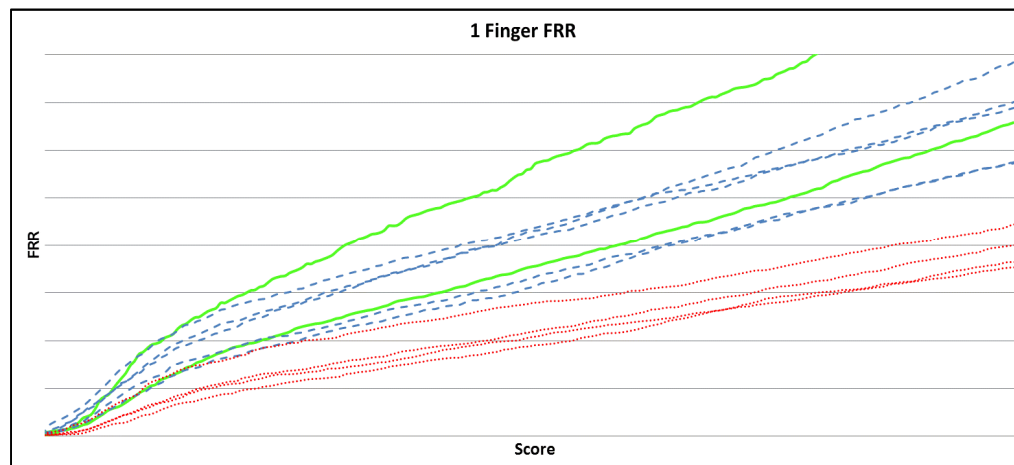
CFPv2 Match Run Results



4- SAME DATASET, DIFFERENT SCENARIOS ...

→ Scenario 1: use 4 fingers

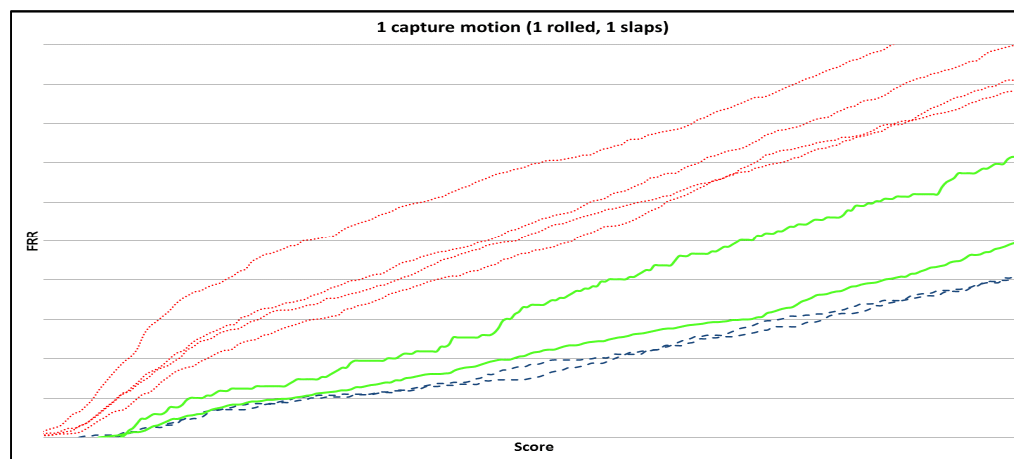
- Capture time not critical
- User experience not critical
- 4 Rolled > 4 Slaps
- 4 Contactless ~ 4 Slaps



4 Contactless
4 Slaps
4 Rolled

→ Scenario 2: one single capture move

- Capture time critical
- User experience critical
- 4 Slaps ~ 4 contactless
- 4 Contactless > 1 Rolled



1 Rolled
4 Contactless
4 Slaps

MORPHOWAVE - NEXT STEPS

→ High end applications

- Border control, enrollment, high end access control, ...

→ Those applications require

- High image quality (geometry, distortion, resolution, ...)
- Full interoperability with legacy systems (sensors, databases, algorithms)
- Importance of user experience and speed

→ ... calling for

- Carefull design of ligthing, resolution and 3D shape estimation
- Independant certification (PIV) and independant testing

→ Next steps

- Is there a need for higher level of compliance verification ?
 - 4 fingers (FAP xxx)? 3D considerations ? Forensic applications (forensic expert) ?
- Or shall we rather keep PIV compliance level and go for more field testing ?

SMARTPHONE FINGERPRINT DIRECT CAPTURE

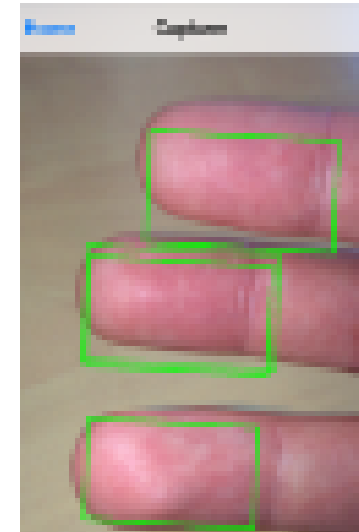
→ Using back camera of smartphone to capture fingerprint

→ Possible applications:

- Mobile ID check
- User authentication

→ Benefit:

- Fast capture of 4 fingers
 - Compatible with existing high end smartphone
 - No need for dedicated sensor, as simple as deploying an App
- ⇒ Very large scale deployment is possible



→ But several legitimate questions:

- What is the accuracy ?
- Is it interoperable with legacy databases and legacy sensors ?
- Performance on a variety of phones ?

And how
can we
validate this ?

DIRECT VIEW TECHNOLOGY

→ Typical HW setting

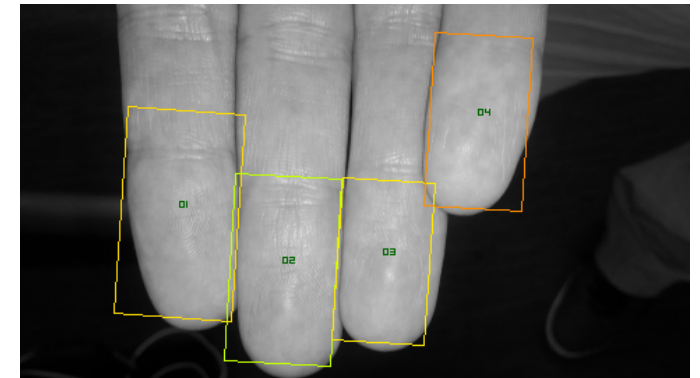
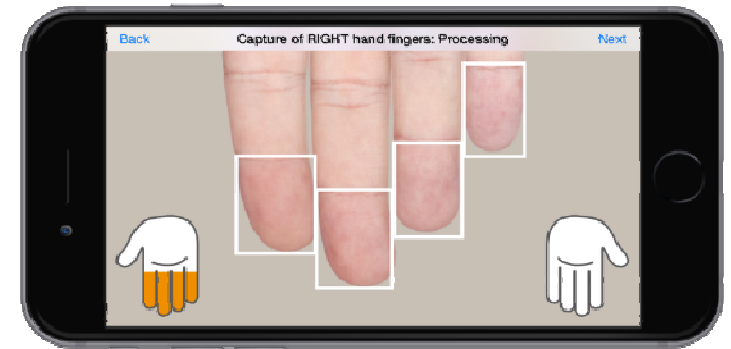
- Use back camera of phone to capture 4 slaps
- Torch mode of flash to enhance contrast
- Auto focus / gain control

→ Typical SW setting

- Auto capture for convenience and speed
- Finger segmentation and sequence check
- Coding/matching

→ Several variations

- Local / remote matching
- Estimation of resolution or resolution-insensitive matcher



1 – INTERNAL TESTING

→ Internal testing

- 183 persons, (right+left hands)
- 2 use cases: self enroll / operator
- In door
- 150K of legacy data (500dpi slaps)
- Traditional matcher with built in tolerance to scale

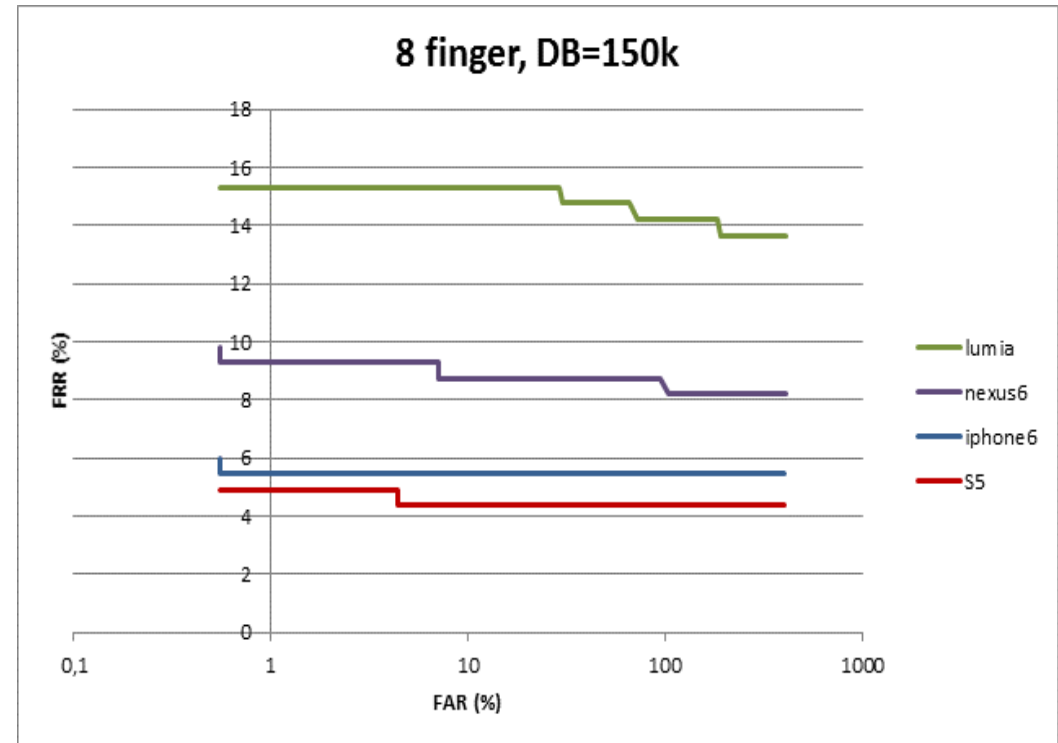
→ Performances is phone dependent

- S5 ~ Iphone6 > nexus6 > lumia

→ Accuracy can be higher than 95%

- Main causes of failure: Autofocus, finger detection & segmentation, hand labelling

→ When fingers are correctly captured, performance scales very well



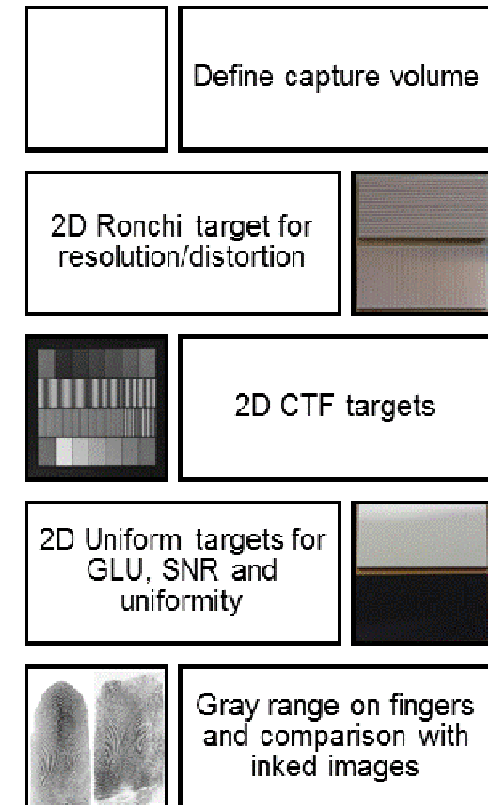
2- PIV CERTIFICATION OF DIRECT CAPTURE ?

→ Image quality of high end phones is very good

- Low intrinsic distortion, increasingly good auto focus/gain control
- ... thanks to a lot of under the wood image processing

→ Open questions for PIV certification

- How to define capture condition for certification
 - Capture volume, external light, ...
- How to accurately control resolution / distortion
 - Scale factor, Finger position&tilt, Finger 3D shape
 - Each of these factor alone can bring more than 2% error
- How to reach native high contrast
- How to relate certification and phone model
 - Inter phone variation - New models every week
 - Intra phone variation Same model can have different camera modules



→ What level of certification is needed for field deployment ?

DIRECT VIEW- NEXT STEPS

→ Possible application

- Mobile ID verification, standard access control

→ Need to define the requirements

- Image quality, interoperability, resolution control

→ What shall be handled at algorithm level versus sensor level

- Most modern algorithms can be set to be robust to uniformity, resolution, ...

→ Especially as we can have 4 fingers per capture

- Unlike with single finger sensors

→ How to measure image quality (PIV certification)

- Adaptation of methodology ?
- Or new level (FAP xxx) for that type of capture devices ?

CONCLUSION

→ New contactless technologies have strong operational potential

- Ease of use, ease of deployment

→ Performance/interoperability requirements can be handled at various level

- Sensor, image enhancement, matching algorithm, system
- This has strong impact on design choices / cost / time to market
 - 3D measurement in Morphowave to ensure full image interoperability
 - Resolution independant matcher in direct view

→ Impact of usability on operational accuracy are not to be ignored

- Ease of use, Speed constraint
- Lab performance is not field performance

→ Validation by standard compliance (e.g PIV) or field testing?

- Need to find the « right » balance

→ Question of use by forensic experts needs to be further discussed

Thank you !

Any questions ?